Teck Coal Elk View Operation
F2 Saturated Rock Fill Project
Full Scale Trial

Report of the Independent Peer Review Panel

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Executive Summary

Teck Coal formed an Independent Peer Review Panel to evaluate the results of the Elk View Operation F2 Pit Saturated Rock Fill (SRF) Project - Full Scale Trial. The Panel convened in Fernie BC the week of February 4 – 8, 2019 to receive presentations on the design of this full-scale trial, the data collected throughout 2018, and concepts for full scale-operation of the SRF system in the F2 Pit. The objectives of the meeting were to: (1) review performance results of the SRF full scale trial and assess the validity of conclusions made by the project team; (2) review the risk evaluations completed, indicate whether significant risks have been overlooked, and assess the validity of conclusions; and (3) review the proposed approach to permanent operations and risk management.

Comprehensive data sets were generated from the SRF field trial and complementary laboratory-based investigations. Following an initial start-up period (January to May 2018), during which time favourable redox and microbial conditions were established, reaction rates were sufficient to result in the near-complete removal of selenium (Se) and nitrate within the 40 m zone between the injection wells and first row of monitoring wells. The Panel finds the SRF system to be robust and resilient, such that variations in influent composition and flow rate did not immediately lead to changes in effluent quality. By controlling methanol dosing, redox conditions were maintained within a range that promotes nitrate and Se reduction, while managing excessive dissolved Fe(II) and H_2S production. The Buffer Pond is viewed as an integral component of the SRF system.

A broad evaluation of project risks has been completed, including those related to longevity, reversibility of selenium attenuation, SRF performance at higher injection rates, and the potential for formation of secondary reaction products. The Panel did not identify any substantive risks that had been overlooked and concurs that reasonable mitigation measures are available to manage the identified risks. The Panel anticipates that the F2 SRF has the capacity to perform at current levels of removal efficiency for selenium and nitrate for several decades at a minimum. The Panel views the reversibility of selenium removal reactions as having a low risk to impact concentrations of total selenium in effluent from the SRF, during both operational and closure phases of the system. Organo-Se release and/or nitrite are potential risks that might require mitigation; in this regard the Panel agrees with the general approach of Trigger-Action-Response Plans, including post-treatment if necessary, to oxidize these species prior to discharge. The Panel anticipates there will be sufficient capacity in the existing system to accept and transmit water for treatment at the higher injection rates proposed. Refinement of water management strategies will benefit from hydraulic testing at higher injection rates.

The proposed approach for permanent operation of the F2 SRF system appears viable. This report concludes with a number of recommendations for consideration by the Project Team that relate primarily to operational efficiencies and monitoring strategy.

1. Introduction

Teck Coal formed an Independent Peer Review Panel to consider the results of the Elk View Operation F2 Pit Saturated Rock Fill (SRF) Project - Full Scale Trial. The Panel convened in Fernie BC from February 4 – 8, 2019 and consisted of Dr. Matt Gerhardt, Dr. Robin Gerlach, Alan Martin, and Dr. Leslie Smith. Other meeting participants included Teck Coal staff (Robert Klein, Liz Karbashewski, Dean Runzer and Thomas Davidson) and project leads from SRK Consulting (Daryl Hockley, Dan Mackie, and Shannon Shaw). Representatives from Enviromin and their collaborators presented the results of their microbiological investigations by teleconference. The meeting included a tour of the F2 Pit SRF project site on February 4. The agenda of the meeting is provided in Appendix A. References are compiled in Appendix B.

The Panel was contracted in November 2018 for the purpose of this review. Dr. Matt Gerhardt has degrees in chemical and civil/environmental engineering and is a Vice President of Brown and Caldwell based in Walnut Creek California. Dr. Robin Gerlach is a Professor in Chemical and Biological Engineering at the Center of Biofilm Engineering at Montana State University in Bozeman Montana. Mr. Alan Martin is an environmental geochemist and Principal with Lorax Environmental Services Ltd. in Vancouver BC. Dr. Leslie Smith is a hydrogeologist in independent practice and Emeritus Professor at the University of British Columbia in Vancouver BC.

The objectives of the meeting were to: (1) review performance results of the SRF full scale trial and assess the validity of conclusions made by the project team; (2) review the risk evaluations completed, indicate whether significant risks have been overlooked, and assess the validity of conclusions; and (3) review the proposed approach to permanent operations and risk management. The performance data considered by the Panel covered the period from January to November 2018, although in some cases, the data sets incorporated more recent measurements.

Teck Coal provided a number of reports to the Panel to aid in preparation for the meeting. These reports are listed in Appendix C. The principal report for this review meeting was "F2 Saturated Rock Fill Full Scale Trial Performance Report", SRK Consulting, January 2019. Appendix C also includes a list of PowerPoint presentations given at the meeting.

2. General Observations

The Panel highlights the following general observations:

1. The hydrogeological and geochemical setting of the F2 Pit SRF make it well suited for the treatment of nitrate and selenium in EVO site drainages. The F2 Pit was filled with waste rock in the 1990's and subsequently covered by a waste rock stockpile. This configuration further isolates the reaction zone from the surface environment and provides a favourable attribute for eventual closure of this area of the EVO mine site.

2. Comprehensive data sets have been generated from the SRF field trial and the complementary laboratory-based investigations. These data sets quantify the hydraulic, geochemical and microbiological behaviour of the SRF.

3. Effective use has been made of hydrogeologic modeling tools to refine the conceptual models describing subsurface fluid flow. These analyses have aided in the estimation of material property values and support the interpretation of a density-stratified flow system that developed in response to the injection of lower-salinity water from Natal West (NW) Pit. Stratification of the water column, which has been sustained throughout the trial, is important in explaining the data collected. However, density stratification of the water column is not viewed as a necessary feature to support future operation of the SRF. Effects that may alter the vertical extent of the zone of lower salinity water, and gradients in water density, will need to be considered in future system design.

4. SRF as an active biological treatment process is fundamentally the same as tank-based treatment systems such as ABMet or fluidized bed reactors (FBRs). SRF incorporates the addition of organic carbon and nutrients to a fixed film bioreactor with hydraulic control. Nitrate is reduced to gas and ultimately released to the atmosphere, while selenium is immobilized within waste rock pore spaces. Removal efficiencies of nitrate and selenium within the reaction zone of the SRF are comparable to those obtained in tank-based systems. Importantly, the treatment process does not produce a separate waste stream (nitrogen degases and selenium is immobilized within the SRF). Distinct from tank-based systems, operation of an SRF requires confirmatory data that the uncertainty inherent in describing the heterogeneity of SRF material properties does not compromise the design and operation of the SRF. The full-scale field trial has provided that data for system operation at 10,000 m^3/day.

5. Examination of the data provided from the full-scale trial strongly supports the assertion that nitrate and selenium reduction occur as a result of microbially-mediated reduction processes; molecular biology results are consistent with the water chemistry data. It should be noted that the data do not provide direct evidence that the microorganisms identified are performing nitrate and selenium reduction, but evidence exists that members of these genera can facilitate these reactions.

6. There is evidence that the overall treatment performance of the SRF can be affected by non-point loading sources. Specifically, the monitoring data suggest that nitrate and selenium are transported to the SRF from upstream waste rock along sub-surface flow paths that bypass the reaction zone established by the injection and pumping wells. The potential significance of these pathways will need to be addressed when planning full-scale operations of the F2 SRF.

7. The Buffer Pond is viewed as in integral component of the SRF system in relation to re-oxygenation of treated waters and the re-oxidation and removal of certain redox-sensitive parameters (e.g., iron).

8. Robust mitigation measures are in place to minimize the potential for non-compliant effluent discharge. Measures include:

   - Hydraulic control: The SRF water level is maintained by active pumping below the decant elevation of the F2 pit;
   - Ability to inject and extract at different rates from different depths and locations;
   - Control of methanol addition to promote effective selenium and nitrate removal, while limiting the development of excessive reducing conditions;
   - Buffer pond: 24 h hydraulic residence time (HRT) at 10,000 m^3/d provides post SRF polishing;
   - Ability to recycle water to NW Pit;
   - Sufficient monitoring frequency to allow for timely implementation of mitigation.

3. Specific Comments on 2018 EVO F2 SRF Full Scale Trial

3.1 Hydraulic Aspects of the Full Scale Trial

Injection of lower density influent from the NW Pit (TDS of ~1,400 mg/L), when compared to the ambient porewater in the F2 pit (TDS of ~2,700 mg/L), contributed to the development of a stratified flow system within the SRF, with the influent water occupying approximately the uppermost 20 m of the saturated rock fill. This behaviour is clearly demonstrated by the vertical distribution of the bromide tracer in the SRF.

Several lines of evidence support the conclusion that the waste rock in the F2 Pit has a high hydraulic conductivity, estimated by SRK to be on the order of 0.1 m/s. The evidence supporting the inference of high hydraulic conductivity includes:

- A very low hydraulic gradient across the treatment zone between the injection and withdrawal points, for the given flow volume and extraction rates.
- A reported uniform rapid water level response observed in the suite of monitoring wells to changes in pumping rates at injection and withdrawal wells.
- The high inflow rates achievable with a gravity injection system.
- The short time period at the start-up of the field trial between bromide injection and detection of bromide in most A-level monitoring wells located 37 and 75 m from the injection location.

- Calibration of the most recent version of the density-dependent groundwater flow model required the adoption of a high hydraulic conductivity value to explain the observed stratification in the water column.

Given the high hydraulic conductivity of the SRF material, inflow to the pumping wells and the monitoring wells was likely localized to a relatively small vertical interval along the well screen at the depth of the pump intake.

The Panel anticipates that the waste rock in the F2 Pit SRF will behave as an anisotropic porous medium. This view is based on the layered nature of the material along tip faces, with intermingled zones of finer and coarser material predicted to occur as a result of textural sorting along the dump face and variations in bulk grain size characteristics of materials from truck load to truck load transported to the pit. The current interpretation of the hydraulic behaviour of the SRF has been based on an isotropic hydraulic conductivity. An anisotropic hydraulic conductivity, together with the depth intervals of the injection and pumping zones, may be a factor contributing to the observed stratification of the water column. This possibility warrants further study. Equations for calculating the hydraulic conductivity in a stratified system where the hydraulic conductivity ellipse is not aligned with the imposed hydraulic gradient are given in Smith and Wheatcraft (1993).

A reasonable layout was adopted for the positioning of the injection, monitoring, and pumping wells for the full-scale trial. The injection well array provided sufficient hydraulic capacity as well as operational flexibility. The use of multiple pumping wells dampened the influence of the inherent spatial variability in water quality within the reaction zone, promoting less variability in the combined effluent, when compared to the variability in solute concentration seen in the monitoring wells. The mixing of flows from the individual pumping wells prior to discharge in the Buffer Pond provided insight to the anticipated system performance during full-scale operations. Further, the mitigation and contingency options available (Buffer Pond, recycle to NW Pit, available storage in F2 pit between the operating water table elevation and the decant elevation) are robust to meet the discharge requirements.

Unanticipated development of a stratified flow system has, in part, demonstrated the effective removal of nitrate and selenium under conditions of shorter than expected HRT. As currently operated, the volume available for reactions is limited by the observed stratification. Further, development of a stratified flow regime allowed for effective placement of pumps within the wells to: (1) permit reliable capture of treated water; and (2) interpret monitoring data.

Detection of elevated nitrate and selenium in pumping well PW-04 suggests solutes originating from external source(s) are migrating to the pumping well from an upgradient location without being fully treated. The cover photo to this report shows a waste rock stockpile to the north of the F2 Pit, which is considered the likely source. This factor will require consideration in the design and operation of the expanded SRF system.

3.2 Biogeochemical Aspects of the Full Scale Trial

Following the initial start-up period (January to May 2018), during which time favourable redox and microbial conditions were established, reaction rates were sufficient to result in the near-complete removal of selenium and nitrate within the 40 m zone between the injection wells and first row of monitoring wells. Nitrate, selenium, and bromide data for MW-18 (installed approximately 10 m from IW-02 in November 2018) indicated these reactions occurred within 10 m of the injection well. Given the small spatial scales of reaction, the Panel concludes that a very small volume of the SRF is being used for nitrate and selenium removal. Moreover, there is no evidence that this volume became exhausted. Therefore, the SRF has substantial treatment capacity.

Nitrate and selenium removal efficiency within the SRF was comparable to tank-based systems. After the start-up period, nitrate concentrations were reduced from approximately 20 mg-N/L in the feed to <2 mg-N/L in the Buffer Pond Outlet (BPO). Selenium concentrations were reduced from 40-150 μg/L to <2 μg/L. Water quality results for the SRF show that selenium reduction was not inhibited by elevated nitrate concentrations, as illustrated by the simultaneous reduction of both parameters.

Nitrate removal rates within the SRF, based on loading at the injection wells and travel time/distance to the first set of monitoring wells, were calculated to range from 4.9 to 5.7 mg/L/d (SRK, 2019). This range is lower than reported values for tank-based systems (e.g., Zaitsev et al., 2008, reported 95 percent removal of 910 mg/L/d in a packed bed reactor). However, removal rates in the SRF were likely higher than the values reported by SRK (2019), since little or no nitrate was found in the first row of monitoring wells (i.e., nitrate had been consumed prior to reaching the Row 1 monitoring wells). Moreover, even though the reaction rate was lower than in a tank-based system, the longer residence time afforded by the SRF allows adequate time for removal of nitrate and selenium prior to influent reaching the pumping wells.

In the SRF pumping wells, selenate was the dominant species with concentrations of selenite being generally an order of magnitude lower. All other selenium species measured in SRF effluent remained below detection limits. Measurable concentrations of potentially more bioavailable selenium species, including dimethylseleneoxide (DMSe) and methylseleninic acid (MeSe), were observed in a few monitoring wells. However, concentrations of these species were generally very low, with elevated values generally occurring over short time frames. Selenium speciation is discussed further below in the "Risk Evaluation".

Due to the large treatment reactor volume, the Panel finds this system overall to be robust and resilient, such that variations in influent composition and flow rate did not lead to changes in effluent quality. Examples of these attributes include:

- The influent selenium concentration varied over a wide range (40-150 µg/L), but the BPO selenium concentration declined steadily until it was consistently <2 µg/L.

- Similarly, there was a wide range in influent ammonia concentration (0.1-0.6 mg-N/L), but the PW-04 concentration was consistently <0.4 mg-N/L. Ammonia concentrations in PW-02 and PW-03 were higher (0.6-0.8 mg-N/L) due to elevated values inherent to the deeper zones penetrated by these wells.

- Perturbations such as system shutdown or excessive methanol addition (caused by an unintentional spill) appeared to cause temporary, localized, higher-than-normal concentrations of nitrite in some monitoring wells, but there is no evidence that BPO concentrations of nitrate and selenium were affected.

At the treatment zone boundary, evidence exists for incomplete removal and ephemeral occurrence of unwanted reaction products (e.g., nitrite, selenite and organo-Se), which are inferred to reflect the effect of non-steady-state conditions at the margins of the treatment zone. Organo-Se species, for example, were highest in the B-level wells, which appeared to collect water from the treatment zone boundary. Nitrite, which is an intermediate reaction product in the biological denitrification process, initially appeared in the A-level wells (which collected water from the highest level, where most of the bromide tracer traveled) before complete denitrification had been established. Later it was found at significant concentrations only in some of the B-level wells.

Phosphorus (P) concentrations within the Buffer Pond have remained low (generally <0.008 mg/L at the combined effluent of the pumping wells and Influent to the Buffer Pond, BPI). This indicates that P introduced through phosphoric acid addition and possibly released during biomass decay is effectively consumed prior to treated water reaching pumping wells. With infrequent exceptions, chemical oxidation demand (COD) and biochemical oxygen demand (BOD) values have remained below detection limits in all pumping wells and BPI. Based on the P, COD and BOD data, the potential for downstream eutrophication is low. Although no additional treatment is anticipated to be required for these parameters, the potential implementation of an Advanced Oxidation Process (AOP) (or equivalent) would provide an effective means to treat COD and BOD.

Bromide served as an effective tracer for the SRF trial, as it allowed the operators to track the movements of subsurface water (i.e., arrival time) and define the proportion of influent water in the pumping wells (i.e., quantify borehole dilution with other water sources). Using correlations with bromide, other naturally occurring constituents such as chloride, sulphate, and uranium were shown to behave similarly (SRK, 2019). Therefore, one of these parameters, total cation equivalents or another externally added tracer could be used as a conservative tracer during full-scale operations in place of bromide.

Reliable selenium and nitrate removal occurred following a start-up period of approximately 3 months. The full-scale trial started in January 2018 and initially (i.e. until about April or May 2018) nitrate and selenium were observed regularly at concentrations above 10 mg-N/L and 20 µg/L Se. These detections mostly occurred in the A and B level wells in monitoring rows 1 & 2. After approximately three months (around the beginning of May 2018), microbial populations capable of nitrate and selenate reduction appeared to have become more strongly established, as evidenced by a decrease in nitrate and selenate concentrations relative to the bromide concentrations (cf. Fig. 5-4 (Br^-), Fig 5-12 (NO_3^-) & Fig. 5-13 (Se), SRK 2019). After that time, nitrate and selenium removal in the SRF appeared to be consistently greater than 90%.

Field and laboratory data support the conclusion that NO_3^- and Se removal occurs through microbially-mediated reduction processes and the molecular biology data support these observations. Nitrate and selenate concentrations decreased relative to bromide concentrations (cf. Fig. 5-4, 5-12 & 5-13, SRK 2019) in the monitoring wells and pumping wells. The observed changes in the relative abundance of ^{15}N and ^{18}O in the remaining nitrate in the SRF indicate an enrichment of these heavier isotopes (due to preferential utilization of lighter isotopes), which is in turn indicative of microbial denitrification. In addition, the results of laboratory studies were reported to show slower nitrate reduction in the absence of an external electron donor, while significant denitrification was observed upon stimulation of SRF material with an electron donor, such as methanol. The SRF results indicate an effect of methanol availability on the extent of nitrate and possibly selenium reduction, again implying a microbially mediated process being responsible for nitrate and selenium reduction. To the Panel members' knowledge, there is no evidence in the literature or in practice that methanol can chemically reduce nitrate or selenium under ambient subsurface conditions (i.e. without active nitrate reducing organisms). Selenate concentrations also decreased, consistent with the microbial reduction of selenate. The observed reduction products, mainly selenite but also more reduced selenium species are also consistent with microbially mediated selenium reduction. The molecular biology data further support the presence of microbial genera linked to members known for their ability to reduce nitrate and selenate.

Active and controlled dosing of an electron donor (i.e., methanol) is necessary to achieve desired redox conditions and removal efficiencies within the spatial and temporal scales of the experiment. Results show evidence of ephemeral increases in nitrate and oxidation reduction potential (ORP) in response to changes in methanol addition, indicating system performance is sensitive to carbon dosing. As indicated above, methanol availability (e.g. dosing) appeared to have an effect on the extent of nitrate and selenium reduction, again implying a microbially mediated process being responsible for nitrate and selenium reduction. Laboratory research has shown that nitrate and selenium reduction occur very slowly in the absence of external electron donor addition, likely making it necessary to add an electron donor (e.g., methanol) to achieve the fast and continuous reduction of nitrate and selenate within the short distances observed in the SRF.

By controlling methanol dosing, redox conditions were maintained within a range that promotes nitrate and Se reduction, while managing excessive dissolved Fe(II) and H_2S production. Excessively reducing conditions could result in the reductive dissolution of iron oxides, which could be associated with the release of compounds sorbed to these phases, such as selenite or arsenic; furthermore, sulfate reduction could result in the production of dissolved sulphide species, which have been associated with the production of more reduced selenium species, such as selenides and certain organo-selenium compounds. The SRF Full Scale Trial indicates that redox conditions were maintained at ORPs between approximately 100 mV and -50 mV with some lower ORPs in the -100 mV range observed in some A level monitoring wells as well as in MW-06B (Fig 5-6, SRK 2019). Slight changes in methanol dosing were implemented based on monitoring well observations.

Accumulation of biomass in and around injection wells occurs and can lead to the capture of particulates. However, the Panel anticipates that biofouling can be managed. Images shown by Enviromin indicated that particulates were captured in the biofilms. A video by a downhole camera in one of the injection wells demonstrated that biomass accumulation inside the injection wells can occur but appears to be limited to the active injection zones; biomass accumulation does not appear to influence injectivity. A biofouling control plan was presented but it has not been necessary to implement biofouling control measures so far (discussed in more detail below).

The Buffer Pond (BP) is an integral component of the SRF system and serves multiple purposes. The HRT and atmospheric exchange afforded by the Buffer Pond allows for effluent re-oxygenation, Fe(II) re-oxidation with subsequent precipitation, some removal of arsenic (presumably in association with re-precipitated iron oxides), H_2S removal, and calcite precipitation. Contact with the atmosphere, for example, allows for the influx of oxygen, which results in dissolved oxygen increases from generally less than 1 mg/L to above 7 mg/L. Further, increases in pH between BPI and BPO (Fig 5-5, SRK 2019), as well as evidence of calcite precipitation, indicate the outgassing of CO_2. The Buffer Pond, however, does not result in the removal of nitrite or selenium. Similarly, the removal of dissolved manganese and ammonia in the Buffer Pond appears to be very limited, which is not unexpected since all of these species exhibit slow oxidation kinetics relative to iron. The Buffer Pond has an HRT of approximately 24 hours (at flow rate of 10,000 m^3/day) and allows for a delay in discharge if indicated by water quality parameters.

4. Risk Evaluation: Current and Expanded Future Operations

During the Fernie meetings, SRK provided their latest compilation of the key project risks and the proposed risk control measures. The risks identified were:

- longevity of the SRF
- reversibility and remobilization of selenium
- preferential flow diminishing the full capacity of the SRF
- effects of higher flow rates on treatment

- variability in the relative proportions of selenium and nitrate concentrations in the influent
- selenium speciation
- nitrite
- bromate formation in an AOP due to use of bromide as a tracer
- trace metal remobilization
- control on effluent water quality
- bio-fouling
- conditions in the closure and post-closure periods.

In the paragraphs below, the Panel provides its view on these identified risks and the proposed control measures. In addition, the Panel provides its opinion on risks related to calcification, and oxygen and H_2S concentrations. The risks discussed have relevance to both the current SRF trial as well as to future full-scale operations.

4.1 Longevity

Rates of selenium and nitrate reduction are sufficiently high to promote near-quantitative removal within short (<10-30 m) distances of the injection wells. In this manner, the current treatment zone represents a very small fraction of the total saturated storage volume available to be utilized for treatment. Further, based on data collected to the end of November 2018, there is no evidence that the currently utilized treatment zones have been exhausted. Given the additional treatment capacity available within the SRF, the Panel anticipates that the SRF has the capacity to perform at current levels of removal efficiency for selenium and nitrate for several decades at a minimum.

SRF longevity has the potential to be influenced by the sequestration pathway for selenium, which may include adsorption of selenite, precipitation of elemental selenium, precipitation of selenide and/or accumulation of organo-Se within bacterial biomass. The adsorption capacity for selenite, for example, will ultimately be limited by the availability of sorption sites. In contrast, given the high permeability of the SRF, the removal capacity for precipitated products (e.g., elemental selenium) may essentially be unlimited (e.g., century time scales). Overall, the conclusion of multi-decadal performance capacity holds true for all possible pathways of selenium sequestration.

The removal capacity for nitrate will be dependent on the presence of an electron donor and sufficient microbial activity, whereby denitrification will result in the removal of N from the system in gaseous form. In this regard, the SRF can be viewed as having unlimited capacity for nitrate removal.

The longevity of the SRF also has the potential to be affected by processes that may result in decreased porosity over time, and a corresponding decrease in hydraulic performance. Such processes could include precipitation of secondary minerals (e.g., elemental selenium, calcite, etc.) and waste rock breakdown and compaction. However, over the times scales of SRF operation (multiple decades), such processes are not predicted to result in any material change to bulk porosity. Further discussion with regards to the potential for calcification within the SRF is provided below.

Based on the collective considerations outlined above, the Panel views insufficient longevity as a low risk.

4.2 Reversibility

No direct evidence exists that describes the nature of selenium removal products within the SRF. However, based on solid-phase speciation analysis of selenium treatment products in other biological treatment systems (e.g., fluidized bed reactors), elemental selenium likely represents a dominant repository for sequestered selenium. Immobilized selenium within the treatment zone may also be present as other reduced compounds including: (1) sorbed selenite; and (2) selenide, precipitated as either discrete sulfide phases, co-precipitated with secondary Fe-sulfides (e.g., pyrite) or as organo-compounds within bacterial biomass. Wells showing evidence of Fe remobilization and low concentrations of selenium and nitrate may provide evidence that selenium adsorption to Fe-oxides is less important. Specifically, selenium adsorption to Fe oxides would not be predicted under environmental conditions that promote their dissolution.

Overall, elemental selenium and other reduced selenium compounds would be predicted to remain chemically stable under conditions of saturation and suboxia, both of which are present within the SRF. Indeed, storage under conditions of permanent saturation represents best management practices for the long-term placement of oxidizable mine waste materials (e.g., potentially acid generating waste rock) (INAP, 2009). Monitoring data for the SRF prior to commencement of the F2 Pit field trial showed the presence of suboxic pore water and low concentrations of selenium and nitrate. These observations reflect the natural tendency of saturated rock fills to develop suboxia, conditions that are conducive to the removal of selenium and nitrate. Accordingly, even in the absence of methanol addition (e.g., closure scenario), conditions of saturation and suboxia are predicted to persist, thus providing a suitable environment for the long-term chemical stability of reduced selenium phases.

In the Panel's opinion, re-oxygenation of the SRF represents the greatest risk for the remobilization of sequestered Se. However, the likelihood of large-scale re-oxygenation is low. Water balance characterization of the F2 pit, as well as monitoring data, demonstrate that the system has a positive water balance, indicating that the SRF will remain saturated in the long term (upper water level governed by natural decant elevation). The potential for re-oxygenation of the SRF as a result of desaturation (i.e., pit draindown) or a large influx of oxygenated water in the absence of an electron donor (i.e., methanol), is considered unlikely.

For redox conditions that result in the reduction of Fe(III)- or Mn(IV)-oxides, selenite associated with these phases may be re-introduced into solution through reductive dissolution processes. However, under these conditions, selenite would be predicted to be reduced and converted into other immobilized species (e.g., elemental selenium or selenide). Shifts in porewater pH and/or ionic strength also have the potential to desorb selenite from particle surfaces. However, given the abundant alkalinity in SRF porewater, and the associated high buffering capacity, large shifts in pH are unlikely. The potential for large shifts in ionic-strength is more difficult to predict, given that this will depend greatly on the source of influent to the SRF.

Under strongly reducing conditions, there is the potential to generate organo-Se (e.g., through assimilatory reduction of elemental selenium). While a release of selenium in the form of organo-Se compounds is theoretically possible, it would require strongly reducing conditions, which could only be induced through the influx of low redox-potential waters or excessive availability of electron donor (i.e., methanol).

Overall, the Panel views the reversibility of selenium removal reactions as having a low risk to impact concentrations of total selenium in effluent from the SRF, for both operational and closure phases of the system. However, where large changes in influent water composition are anticipated (e.g., shift to Erickson Creek as water source), flows from these other sources into the SRF should be increased gradually to permit identification of potential changes in SRF performance.

Nitrogen removal through denitrification is not associated with a reversibility risk because complete denitrification will result in the release of nitrogen gas to the atmosphere. Some mobilization of nitrogen as ammonium will occur as a result of biomass decay within the SRF during operations. However, this nitrogen release will occur slowly and the regeneration of biomass will consume released ammonium quickly. The likelihood of low release rates for ammonium is supported by the field trial monitoring data which show invariant effluent (BPO) values generally <0.6 mg-N/L. If pumping well NH_4^+ concentrations trended up, post-treatment (e.g., Moving Bed Biofilm Reactor) could be implemented. AOP is not generally effective for ammonium oxidation.

4.3 SRF Performance at Higher Injection Rates

The Panel was advised that the treatment capacity of the SRF is planned to increase to 20,000 and possibly 40,000 m^3/d to meet requirements for treatment of water in Erickson Creek. System performance at 20,000 and 40,000 m^3/d has not yet been demonstrated. This presents a potential risk for sub-optimal design of the well field with respect to groundwater velocities and the required HRT. Three-dimensional flow modelling and performance evaluation will aid in assessing hydraulic characteristics of an expanded operation, and thereby allow for system optimization (see Recommendations).

Given the apparent high hydraulic conductivity of the SRF, the Panel anticipates there will be sufficient capacity in the existing system to accept and transmit water for treatment at the proposed injection rates. Using the existing injection well array, there will be a decrease in HRT and a risk of preferential flow development (at the local scale) in response to increased flow rate. This could result in reduced treatment efficiency. The Panel agrees that the proposed mitigation strategy (addition of other injection and extraction wells and ability to vary injection flow rate) will provide an effective means to manage this risk. Refinement of water management strategies will benefit from hydraulic testing at higher injection rates (see Recommendations).

4.4 Preferential Flow

The material properties of the SRF are anticipated to be spatially variable. However, within the treatment zone, both field data and modeling results suggest that a working assumption of uniform flow can reasonably explain the field observations during the full-scale trial. These results indicate that while heterogeneous at the local scale, the waste rock that hosted the treatment zone during the full-scale trial can be approximated as a homogeneous unit.

The Panel does not anticipate that the performance of the SRF would differ significantly if lower portions of the SRF were utilized for treatment, or if unanticipated movement of influent occurred to depths below the current treatment zone. This observation is based on the assumption of similar material and hydraulic properties throughout the majority of the SRF. There may be a modest decline in hydraulic conductivity with depth due to self-weight consolidation. Confirmatory hydraulic testing of deeper zones in the F2 infill waste rock, similar to that already undertaken for the upper 20 m of the SRF, is recommended before the SRF operations are to be expanded or modified to move the reactions to deeper zones.

If the injection and extraction wells were to penetrate a basal rubble zone of extremely high hydraulic conductivity, treatment could be compromised by insufficient HRT. Defining an offset distance between the top of any potential rubble zone and the elevation of extraction well screens can mitigate this risk.

The Panel anticipates that with the current configuration of the well field, and the density differences between influent water and ambient porewater, the observed stratification in the SRF will be maintained. Injection of lower density influent (e.g., low salinity from Erickson Creek at freshet) has the potential to decrease the thickness and HRT of the reaction zone. The Panel believes that this risk can be mitigated through flow and density management strategies.

4.5 Calcification

The Panel agrees that there is a likelihood of calcium carbonate ('calcite') precipitation to occur within the SRF as well as upon pumping treated water from the SRF. The potential for calcification within the SRF could lead to a decrease in porosity, permeability and thus removal efficiency. There is no evidence of significant calcite precipitation occurring within the SRF based on the inspection of coupons that have been employed in the wells periodically. The Panel does not expect significant calcite or similar mineral precipitation to occur unless a dramatic change in water chemistry occurs. This could happen through mixing with other water sources such as water from deeper strata within the SRF or if influent waters have drastically different water chemistries accompanied by high calcium and/or HCO_3^- concentrations. Water from the NW Pit and Erickson Creek will be generally in geochemical equilibrium with their surrounding environment and only changes in water chemistry, such as pH, alkalinity, or Ca-concentration changes, will induce significant calcite precipitation. Hence, dramatic changes or differences in water chemistry are not expected to occur. Even if dramatic changes or differences in the water chemistry of water injected in the SRF occur (e.g. through the use of yet another water source in the future), the potential for calcite precipitation is likely only increased temporarily and only in the areas where mixing of waters with different water chemistry occurs. The potential for calcite precipitation in relation to the processes described above can be predicted through geochemical modeling. Lastly, even if calcite precipitation occurred, the pore space within the SRF is so large that significant, large-scale effects on hydraulic conductivity would only be observable over decadal or centurial timescales.

The risk of calcite precipitation upon pumping from the SRF must also be considered. The few indications of toxicity of Buffer Pond Outlet (BPO) samples have been tied solely to calcification. A few *Daphnia magna* tests failed, and based on additional interrogation of the causes, it was determined that the toxicity can likely be attributed to calcification (i.e. the precipitation of calcium carbonate on the *Daphnia*). In laboratory tests, toxicity was shown to be reduced by the samples with antiscalant, acidification to pH 5.0, and filtration after adjustment to pH 10. The combination of these observations is consistent with toxicity caused by calcite precipitation. The increase in calcite precipitation potential in the pumped SRF water is likely due to an increase in carbonate alkalinity during passage through the SRF. Nitrate reduction is known to increase alkalinity; however, within the SRF, precipitation is unlikely to occur because CO_2 concentrations also likely increase during treatment. This would reduce the likelihood of calcite precipitation within the SRF. Upon being pumped out of the SRF and contacting the atmosphere, CO_2 outgassing occurs, thereby increasing the potential for calcification in the surface water system (as described in the specific comments above). The resulting increases in pH values (Fig 5-5, SRK 2019) and evidence of calcite precipitation indeed indicate the outgassing of CO_2. The potential for calcification-based toxicity can be mitigated through facilitated calcite precipitation upstream of the final discharge to the environment. Possible options include enhancing CO_2 outgassing and precipitation (e.g., via a cascading outflow from the buffer pond). This would also result in additional aeration and possibly additional removal of reduced iron, manganese as well as arsenic, although the kinetics of re-oxidation and removal might be slow and removal efficiency would have to be evaluated and monitored. Other options, if necessary, include the addition of lime followed by flocculation, and sedimentation or filtration, pH adjustment or the addition of antiscalants.

While the Panel considers calcification a risk, it is considered a low risk because dramatic changes or differences in water chemistry are not expected and because calcite precipitation in the SRF outflow can be managed through a variety of measures, which were outlined here and in the risk management plan presentation. An influence on the porosity (and thus permeability) of the SRF is deemed unlikely by the Panel, even if significant precipitation of calcite occurred. The Panel recommends conducting aqueous chemistry modeling to better understand and predict the potential for mineral precipitation within and upon pumping from the SRF as well as to further inform the implementation of calcite management strategies (see Recommendations).

4.6 Undesirable Selenium Species in Effluent

Potential risks associated with selenium speciation will relate to the presence of more bioavailable species in the SRF effluent, including selenite and in particular, organo-Se species. As presented above, SRF effluent was dominated by selenate and minor proportions of selenite, with all other species remaining below detection. Undetectable levels of organo-Se species in the SRF effluent relate to the localized nature of occurrence in the well field (i.e., dilution upon mixing with other waters upon discharge) as well as to their possible degradation or bacterial consumption prior to reaching the pumping wells. "Missing" selenium species are also relatively abundant in some BPI samples, particularly during the first 5 months of the experiment. In this context, the concentration of "missing" species is calculated as the difference between the total selenium and the sum of all known and unknown species. The nature of the missing fraction is not well understood and may represent elemental selenium or other species that do not register as defined peaks in the chromatogram.

Measurable concentrations of potentially more bioavailable organo-Se species, including DMSe and MeSe, were observed in several monitoring wells. However, concentrations of these species were generally very low and their presence ephemeral. The highest concentrations of these species were observed in wells located in the lower part of the presumed reaction zone (MW-02B and MW-06B), possibly reflecting boundary layer effects at the edge of the treatment zone (e.g., non-steady-state effects relating to varying availability of methanol).

Given the detection of organo-Se species within the well field, and the uncertainty relating to the controls governing organo-Se generation and behaviour, the Panel views the potential for organo-Se release as a potential risk that might require mitigation. In this regard, the Panel agrees with the general approach of a Trigger-Action-Response Plan, including post-treatment if necessary, to oxidize these species prior to discharge. The specific trigger thresholds will require careful consideration due to the complexity in relating organo-Se concentrations to bioavailability and toxicity. The turnaround period for organo-Se analysis must also be factored into the overall management framework. The Panel also recommends the implementation of bioassay test work to better quantify selenium bioavailability in SRF effluent (see Recommendations).

4.7 Oxygen and H_2S in Effluent of Buffer Pond

The HRT and atmospheric exchange afforded by the Buffer Pond allows for effluent re-oxygenation and removal of dissolved H_2S via volatilization or oxidation. As discussed above, the Buffer Pond is considered an integral component of the SRF system and indeed allows for seemingly complete oxygenation of the water pumped from the SRF as well as for the removal of the small amounts of dissolved H_2S that have been exiting the SRF. The BP also serves other purposes, including iron re-oxidation and a decrease in the calcification potential. The Panel considers the current water management strategy an effective means to mitigate the risk of H_2S or low oxygen concentrations to affect effluent water quality.

4.8 AOP Oxidizes Bromide to Bromate

Much of the bromide that was used during the 2018 full-scale trial remains in the SRF. In the future, if the SRF-treated water is oxidized in post-treatment (e.g., AOP treatment) to destroy nitrite, selenite, and/or organo-Se compounds before discharge, the bromide might be oxidized to bromate, which is a suspected human carcinogen. As expected, monitoring data show that bromide concentrations in the water pumped from the SRF have been declining since the cessation of bromide injection. Going forward, it will be important to limit future bromide addition and to continue pumping from the SRF to facilitate bromide removal before a post-treatment system incorporating oxidation is installed. An estimate of the time to reduce the SRF effluent bromide concentration to acceptable levels should be developed (see Recommendations).

4.9 Biofouling

Biofouling is viewed by the Panel as an operational or maintenance risk only. Potential for biofouling to alter hydraulic performance (through decrease in permeability) is not predicted to be a significant risk to overall performance. As discussed above, there appears to be some biofouling but it appears to be limited to the active injection zones and does not appear to influence injectivity. A biofouling control plan is in place but no biofouling control has had to be implemented so far. The Panel considers this an operational issue only and no impact on SRF performance is expected. Hence, the Panel judges the risk of biofouling affecting SRF performance in the future as low.

4.10 Highly Variable Nitrogen:Selenium (N:Se) Ratio

The Panel is convinced that nitrate is the primary electron acceptor in the SRF after oxygen is depleted and supports much of the growth and activity of nitrate and selenium reducing microbes. The ratio of nitrate:Se is always high and is not expected to affect removal of either parameter. If the nitrate:Se ratio, against expectations, affects the performance of the SRF in the future, a possible mitigation is the blending of influent water with another water source, e.g. Erickson Creek and NW pit waters. Again, the panel views this as a very low risk and does not believe this will affect SRF operations. Changes in the nitrate:Se ratio are predicted to occur gradually in response to the depletion of residual blasting residues following facility closure (i.e. on multi-year time scales), and the reduced electron donor demand can be accommodated through reduced injection of methanol or another suitable electron donor. The NW Pit could certainly be considered for mixing influent waters to maintain a certain nitrate:Se ratio but the Panel does not conclude from the data presented and the data available in the literature that such measures would be necessary.

4.11 Mobilization of Trace Metals

Under more reducing porewater conditions where Mn(IV) and Fe(III) reduction is possible, the reductive dissolution of Fe- and Mn-oxides is expected. This is illustrated by background pore water data for the SRF that show the natural enrichment of both dissolved Mn (median background = 1.0 mg/L) and Fe (median background = 0.14 mg/L). To date, however, Fe and Mn concentrations at the pumping wells have not differed appreciably from the background, indicating that the treatment system is not currently resulting in the enhanced remobilization of Mn and Fe..

Given that some degree of Fe & Mn oxide reductive dissolution can be expected, the potential for trace element remobilization must be considered. The water quality data for several Row 2 monitoring wells, for example, show trends of increasing dissolved arsenic concentration (presumably released in association with Fe oxide reductive dissolution), with maximum values of over 0.005 mg/L (BC aquatic life guideline). In SRF effluent (BPO), however, arsenic concentrations have remained below 0.001 mg/L.

Overall, the Panel views the near-term risk for non-compliance with regards to Mn, Fe and arsenic as being low. However, given evidence of increasing arsenic concentration in several Row 2 monitoring wells and at BPO, arsenic should be included in the Trigger-Action-Response plan. Nickel (which is elevated in F2 Pit background water) and cobalt (which shows evidence of remobilization in concert with Mn-oxide reductive dissolution) should also be included in plan development.

4.12 Nitrite in Effluent

Data suggest that nitrite is generated at times through incomplete denitrification, with peaks observed during system perturbations such as:

- Startup – there were peaks of nitrite concentration in the A-level wells in February 2018, shortly after startup.
- Changes in methanol feed – peaks were observed in June 2018 when the methanol feed rate was being adjusted.
- Boundary effects – bromide data show that the B-level wells began collecting water associated with the SRF influent in June 2018, approximately 4 months after the A-level

wells, and nitrite began appearing in July 2018, indicating that the treatment zone had expanded to the B-level.

Within the SRF, nitrite toxicity to bacterial assemblages is not expected. However, discharged water must comply with a discharge criterion of approximately 0.2 - 0.4 mg-N/L. The BPO nitrite concentration ranged from 0.01 to 0.037 mg/L, which is below the assumed discharge criterion. The Panel was informed that the discharge limit might be reduced to 0.1 mg-N/L or lower under conditions of lower chloride content, such as when water from Erickson Creek becomes an important influent source (BC nitrite guideline is dependent on chloride concentration).

Based on these monitoring and permitting considerations, some form of post-SRF nitrite removal system is expected to be required for consistent compliance. The Panel agrees with the general approach of a Trigger-Action-Response Plan, including post-treatment, if necessary to remove nitrite prior to discharge.

4.13 Nitrous Oxide

While isotope testing shows that denitrification is occurring in the SRF, there was no direct measurement of nitrogen gas (N_2) production that could be used in a mass balance. The Panel notes that it would be difficult to quantitatively assess an increase in nitrogen gas concentrations because the background nitrogen level in the atmosphere is approximately 80%. It is possible that the SRF is producing some nitrous oxide (N_2O), a greenhouse gas with a global warming potential 298 times higher than that of carbon dioxide. The fraction of nitrogen that is converted to N_2O rather than N_2 in denitrification systems is reported in the literature over a range of 0.01 percent to 3.3 percent (Chandron, 2012; Bruun, 2015). Soil gas samples should be collected and analyzed for N_2 and N_2O to quantify the potential contribution in greenhouse gas emissions (see recommendations).

4.14 Effluent Compliance at Closure / Post Closure

The Panel concurs with the proposed management plan which specifies that for periods when SRF water quality is non-compliant for discharge, the pit water elevation can be maintained at a level below the decant elevation by pumping and treating prior to release.

5. Recommendations

The Panel provides the following set of recommendation for consideration by the project team.

5.1 Higher Priority

1. For future water quality monitoring of an operational system, a sub-set of the monitoring wells should include shorter well screens (~1.5 m) to allow for higher-resolution sampling of the SRF reaction zone and avoid uncertainties arising from borehole dilution. This sampling approach may be of particular value for defining water quality trends in the fringe of the treatment zone.

2. In order to reduce uncertainty with regards to the bioavailability of selenium in SRF effluent, it is recommended that site-specific selenium bio-accumulation studies be conducted. This could involve paired bioassay experiments that would compare the bio-accumulation of selenium to algae in both influent (e.g., NW Pit water) and effluent (BPI) samples. Samples obtained from monitoring wells could also be evaluated, particular for those showing higher concentrations of organo-Se species (e.g., MW-02B and MW-06B). A unicellular organism, such as an algae, is recommended since the greatest potential for selenium food-chain accumulation is dominantly controlled by the uptake of selenium from water into primary trophic levels. Specific objectives would be to develop bioconcentration factors that could be incorporated into trophic transfer models to evaluate the risk to higher taxa (e.g., fish). Experimental methods such as those described in Amweg et al. (2003) should be considered.

3. A three-dimensional, uniform density flow hydrogeologic model should be developed for the proposed operational system to allow for the: (1) design and optimization (e.g., depth, location, capacity) of injection and withdrawal points; and (2), evaluation of alternative pumping/withdrawal strategies during operations, if required. The vertical extent of the domain can be guided by insight gained from the existing two-dimensional, density-dependent flow model.

4. If non-point source, external loadings of nitrate and selenium (i.e. from fresh waste rock placed into the surface water / groundwater catchment of the SRF) compromise effluent quality significantly, consideration should be given to the creation of a reaction zone between those external source(s) and SRF pumping wells. SRK has also considered the alternatives of either using low-flow interception wells to capture the external flows and adding that water to the main influent stream, or re-orientation of the injection and pumping wells to incorporate these flows within the treatment zone.

5. As discussed above, there is a risk of calcite precipitation within the SRF as well as external to the SRF upon pumping from the treatment system. The Panel considers this risk as manageable and plans for remediation are well-conceived. Consideration should be given to more detailed geochemical modeling to better understand and predict the potential for mineral precipitation within the SRF and to constructing a cascade system between the Buffer Pond and the Bodie Creek Rock Drain to facilitate calcite precipitation prior to the dissipation box. Appendix J of the "F2 Saturated Rock Fill Full Scale Trial Performance Report" (SRK 2019) presents an updated conceptual model and there appears to be significant knowledge and insight regarding calcification risks (e.g.,

through geochemical modelling). However, to further advance our understanding of calcification risks, it is specifically recommended that (i) the kinetics of calcium carbonate ('calcite') precipitation and dissolution, and (ii) the influence of precipitation inhibitors such as naturally occurring chelators, are taken in account in designing risk management strategies. Several treatment technologies are either in operation or being considered by Teck at other locations. However, it is beyond the scope of this Panel to recommend a specific system to manage calcite during expanded SRF operations..

6. In relation to higher flow rates, refinement of water management strategies will benefit from hydraulic tests at higher injection rates. Where large changes in influent water composition are anticipated (e.g., shift to Erickson Creek as water source), flows from these other sources into the SRF should be increased gradually to permit identification of potential changes in SRF performance. Confirmatory hydraulic testing of deeper zones in the F2 infill waste rock is recommended before the SRF operations are modified or expanded to move the reactions to deeper zones. No substantive impact on project schedule in moving to a full-scale operational SRF system is foreseen if these tests were to be undertaken.

7. Because a methanol spill caused the oxidation-reduction potential (ORP) to decrease in the well nearest to the spill, and elevated iron concentrations were measured at that well after the ORP had fallen, all methanol infrastructure (storage, pumping, and piping) should be placed as far as possible from pumping wells and/or installed with secondary containment. Such measures will provide sufficient time for an unanticipated methanol release to degrade before it can have an impact on SRF effluent.

8. Pumping through the SRF should continue in order to remove accumulated bromide. The amount of time needed to reduce the bromide concentration to acceptable levels should be calculated. This time will be dependent on factors including pumping rate and relative proportions of shallow and deep water extracted. During this time, no more bromide should be added as a tracer.

9. If there is no proven benefit to pulsed injections of methanol in terms of minimizing biofouling, the Panel recommends continual injection to minimize non-steady-state conditions within the SRF. Perturbations (e.g. through the methanol spill) might have led to nitrite detections, increased dissolved iron concentrations as well as detection of dissolved manganese, arsenic and organo-Se compounds in the SRF.

10. While minerals such as quartz particulates were detected in biofilm samples collected from the wells, there appears to be no evidence that injectivity of the injection wells was affected. Significant accumulation of minerals inside wells could ultimately affect hydraulics of the SRF but fouling control measures have been outlined and appear well conceived to the Panel. An abundance of sediment associated with the influent to the SRF could however affect the hydraulics of the SRF in the short- and long-term.

Accordingly, TSS monitoring (and control, if necessary) of the influent is considered to represent an integral component for permanent SRF operations.

11. SRF soil gas samples in the unsaturated zone should be collected and analyzed for N_2O; if detected, its flux should be estimated and incorporated into the overall carbon footprint calculation for this treatment process.

12. The Panel is confident that the SRF will effectively retain selenium removed in the SRF even under perturbation scenarios. It is, however, recommended that research be continued to develop a better understanding of the ultimate fate of selenium as well as the potential for remobilization. It should be noted that the Panel does not view these knowledge gaps as factors that would influence the timing of implementation of a full-scale operational SRF. Mineralogical information derived from the biocoupon monitoring program could become an important means for this effort. Additionally, selenium stable isotope measurements (in both influent and effluent) may provide a valuable complement to the evaluation of selenium removal pathways.

13. At least during the start-up period of a possible full-scale application of an SRF, the NW Pit should be considered as a buffer for excess flows that might not yet be treatable, for potential density equilibration, recycling, or storage of water that does not yet meet treatment goals. The possibility of direct recycling from pumping wells to injection wells should also be considered in the design of permanent operations.

14. There appears to be uncertainty regarding the exact location and elevation of the natural decant point for the F2 pit. Given the importance of the natural decant with regard to overall water management, efforts should be taken to increase the confidence in the current estimates.

5.2 Lower Priority

1. For long-term planning, Teck should evaluate the advantages of alternative SRF construction methods. For example, bottom-up construction of backfill within an SRF facility would allow for more uniform particle size distribution (e.g., elimination of basal layer boulder zones), and potentially more predictable hydraulic behaviour.

2. Development of other SRFs should consider the potential to operate under longer HRTs, allowing for reduced addition (or elimination) of DOC. Such systems would be predicted to be less prone to the generation of organo-Se species. This type of system may have most relevance in the long-term (post-closure period) when nitrate loads have diminished and selenium is the primary target parameter (i.e., when lower system energetics are required to meet discharge objectives).

3. For elements of potential concern such as cobalt and nickel, complexation with organic-ligands within the SRF treatment zone may decrease their bioavailability. Consideration should be given to quantifying the bioavailable fraction of these metals through methods such as Diffusive Gradients in Thin Films (Zhang and Davison, 1995). Such data may be used to explain the results of toxicity test work and complement the assessment of potential adverse effects to receiving streams.

4. Statements such as “Baseline community analysis showed the presence of denitrifiers at all sampling locations.” and “Selenium reducing populations dominated by members of the genus Dechloromonas though Pseudomonas were detected in trace abundances in monitoring well and pumping well samples” should be avoided as they link taxa to function. More appropriate wording could include “Baseline community analysis indicated the presence of organisms known to be members of genera described to be capable of denitrification.” or “Members of the genus Dechloromonas and low abundances of Pseudomonas were detected in monitoring well and pumping well samples; these genera have been described to include selenium reducing members.” – there are other instances in the report, which should be evaluated in view of their validity.

6. Closure

We trust this report meets your requirements at this time. Should you have any questions or comments, please do not hesitate to contact the undersigned.

Sincerely,

Independent Peer Review Panel

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